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The Lund-Mackay Score for Adult Head and Neck Computed Tomography

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ABSTRACT

In order to obtain an objective Taiwanese control Lund-Mackay scoring (LMS) dataset, we performed a retrospective study that involved 600 patients, who had undergone head and neck CT scans between July 1st 2008 and November 12th 2010. After non-adults (less than 18 years old) and those with rhinosinusitis, head and neck trauma, epistaxis or cancer with head and neck radiotherapy were excluded, 490 adults (248 males and 242 females) were enrolled for the study group. In addition, 119 adults (55 males and 64 females) were enrolled for the control group that had been diagnosed with rhinosinusitis and received the first sinus CT scans for workup of disease severity or presurgical evaluation. The right or left sinuses were respectively divided into six portions, including maxillary sinus, anterior ethmoid sinuses, posterior ethmoid sinuses, sphenoid sinus, frontal sinus, and ostiomeatal complex. The severity of sinus mucosal inflammation or fluid accumulation for the above six portions were unilaterally and bilaterally summed to respectively give separate unilaterally and bilaterally total LMS values. As a result, in the study group, the bilaterally total LMS obtained for the dataset was 0.96 ± 1.91 (mean ± SD) with a right total LMS of 0.46 ± 1.28 and a left total LMS of 0.50 ± 1.41. In the control group, the bilaterally total LMS obtained for the dataset was 8.72 ± 7.18 with a right total LMS of 4.35 ± 3.84 and a left total LMS of 4.37 ± 3.98. There were significant differences between the study and control groups in the unilateral or bilaterally total LMS. Therefore, when a patient's bilaterally total LMS is great than 5 (mean plus 2SD is 4.78) or when a patient's unilaterally total LMS is greater than 4 (mean plus 2SD for right is 3.02 and for left is 3.32), he or she is beyond 97.7% of the common population.

Dedicated sinus computed tomography (CT) has been a useful tool in assessing patients with sinus disease, especially before surgical intervention. Lund and Mackay suggested a rhinological staging system. This included a radiological score that permitted effective evaluation and allowed communication with other specialists about the severity of rhinosinusitis [1]. Out of the various systems that have been developed, the Lund-Mackay score (LMS) has proved to be an effective assessment method and an easy imaging research tool to use in practice [2, 3].

Ashraf et al. [4] described the use of a controlled LMS value, in which they used the bilaterally total LMS. In addition, Huang et al. [5] provided a Taiwanese controlled LMS dataset, in which they used separate 214 unilaterally total LMS values of 107 persons, but the case number may be not enough to represent the Taiwanese general population for National Health Insurance purposes. In order to obtain a more-objective dataset, a retrospective study was performed involving more patients and more CT scans.

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MATERIALS AND METHODS

Between July 1st 2008 and November 12th 2010, 600 individuals (312 males and 288 females) had received the first head and neck CT scans and 126 individuals (68 men and 68 females) had received the first sinus CT scans at a hospital in North Taiwan. Herein, head and neck CT scans were the study group and sinus CT scans were the control group. We only reviewed their first CT scans at our hospital although one patient might have two or more scans. Two multi-detector spiral CT units (LightSpeed^{TM} VCT, GE Healthcare, USA and BrightSpeed^{TM} Elite, GE Healthcare, USA) were employed. Patients were imaged in the supine position with their head entering the gantry.

Study Group (Head and Neck CT Scans)

Coronal and axial views were obtained from the scout images using the head top as landmark and data from the head top to the sterno-clavicular joint were collected using continuous scanning images in the helical mode (slice thickness: 1.25mm, interval: 0.8 mm, KV: 120). After 21 non-adults (less than 18 years old), 29 with rhinosinusitis, 45 with head and neck trauma, 1 with epistaxis, 14 with head and neck radiotherapeutic history were excluded, there were 490 adults (248 males and 242 females) in the study group and these were aged 51.5 ± 16.6 (mean ± SD) years (range: 18~92). They received the first head and neck CT scans for workup of neck mass (n=220), deep neck infection (n=66), oral mass (n=34), lymphoma (n=33), possible cervical vascular disease (n=30), salivary gland disease (n=18), cellulitis (n=17), possible foreign body impaction (n=11), headache and nuchal pain (n=10), pre- or post-dental treatment evaluations (n=8), nasopharyngeal mass (n=6), hypopharyngeal mass (n=6), laryngeal mass (n=4), vocal palsy (n=3), possible neck metastasis of post-operative breast cancer (n=3), temporomandibular joint disorder (n=2), cervical spine disease (n=3), oropharygneal mass (n=3), possible esophageal tumor (n=2), orbital mass (n=2), nasolabial cyst (n=2), auditory canal mass (n=1), mandibular mass (n=1), scalp mass (n=1), health check-up (n=1), possible eagle syndrome (n=1), pituitary gland tumor (n=1) and anterior neck fistula (n=1).

Among the 490 patients, 22.9% (n=112) was performed in the spring; 27.1% (n=133), summer; 31.0% (n=152), autumn; and 19.0% (n=93), winter. Furthermore, 55.5% (n=272) were performed in the morning (6:00 AM~12:00 AM), 34.7% (n=170) were performed in the afternoon (12:00 AM~6:00 PM), 8.4% (n=41) were performed in the evening (6:00 PM~0:00 AM) and 1.4% (n=7) were performed during the night (0:00 AM~6:00 AM).

Control Group (Sinus CT Scans)

Coronal and axial views were obtained from the scout images using the frontal sinus top as landmark and data from the frontal sinus top to the hard palate were collected using continuous scanning images in the helical mode (slice thickness: 1.25mm, interval: 0.8 mm, KV: 120). After 6 non-adults and 1 with inverted papilloma were excluded, there were 119 adults (55 males and 64 females) in the control group and these were aged 50±15.8 years (range: 19~85). They had been diagnosed with rhinosinusitis and received the first sinus CT scans for workup of disease severity or pre-surgical evaluation.

Lund-Mackay CT Scoring

The right or left sinuses were respectively divided into six portions, including maxillary sinus, anterior ethmoid sinuses, posterior ethmoid sinuses, sphenoid sinus, frontal sinus, and ostiomeatal complex. The severity of sinus mucosal inflammation or fluid accumulation was scored as 0 (complete lucency), 1 (partial lucency) or 2 (complete opacity). Please note that mild mucosal thickening without fluid collecting was scored as 0; mild mucosal thickening with fluid collecting causing partial lucency scored as 1; and, moderate or severe mucosal thickening without fluid collecting causing partial lucency, but not complete opacity, scored as 1. In addition, the ostiomeatal complex was scored as either 0 (not obstructed) or 2 (obstructed) because it is difficult to describe the ostiomeatal complex with any gradation (Fig. 1).

The ten scores for the various sinuses and bilateral ostiomeatal complexes were summed to give a bilaterally total LMS that could range from 0 (complete lucency of all sinuses) to 24 (complete opacity of all sinuses). In addition, unilateral five portions of the sinuses from either the left or the right and one ipsilateral ostiomeatal complex were also summed to give separate unilaterally total LMS values that could range from 0 to 12.

Statistical Analysis

The dataset was correlated using Excel 2000 Microsoft and the statistical analysis was performed using the same software. A two-tailed Student's t-test was used to analyze the total LMS between the study group and the control group. A p value lower than 0.05 (a t value greater than 1.96) was considered statistically significant.

RESULTS

When a patient's bilaterally total LMS is great than 5 (mean plus 2SD is 4.78) or when a patient's unilaterally total LMS is greater than 4 (mean plus 2SD for right is 3.02 and for left is 3.32), he or she is beyond 97.7% of the common population.

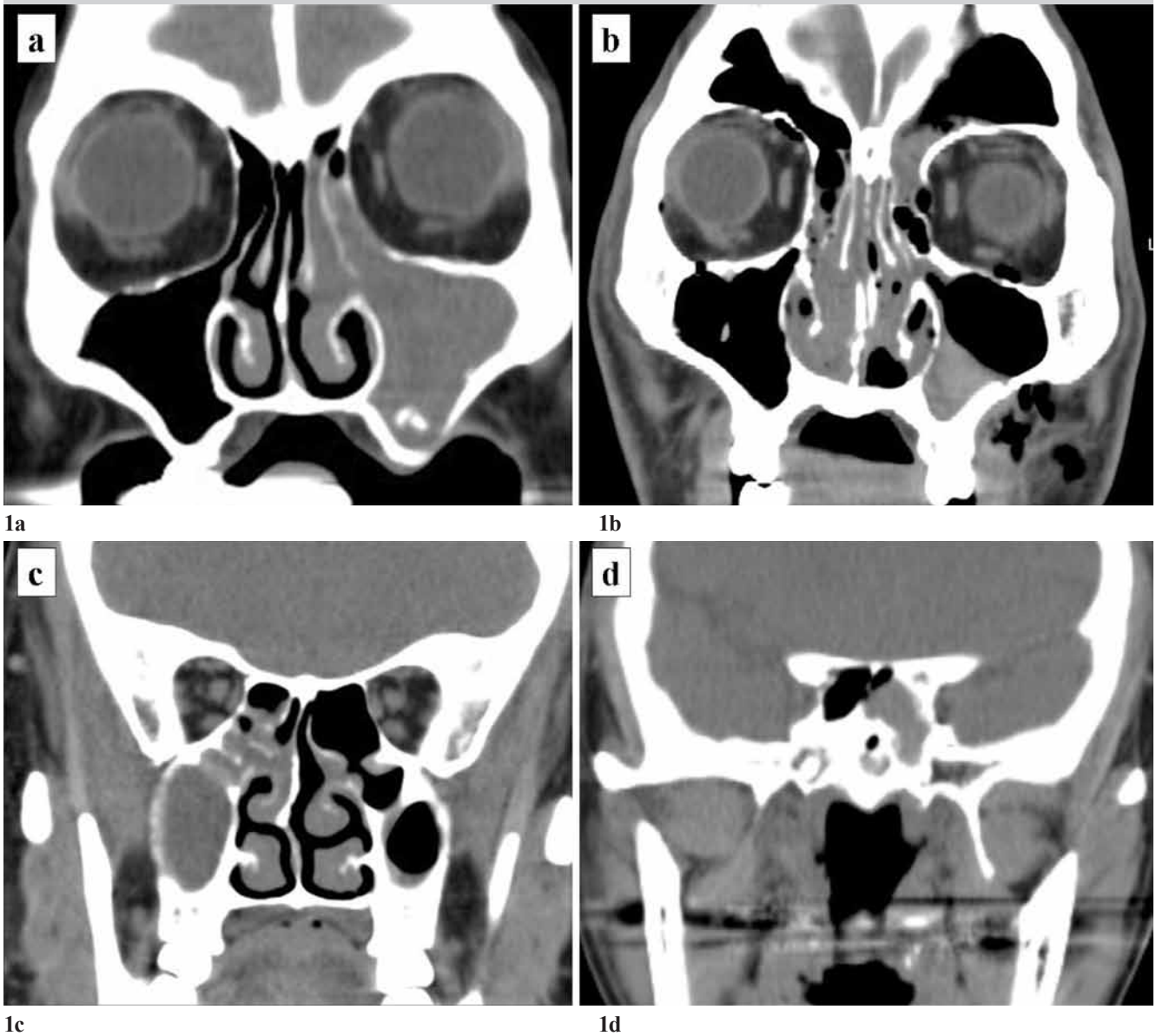
Study Group

The LMS for each sinus is presented in Table 1 and it was found that the bilateral total LMS was 0.96 ± 1.91, with a range from 0 and 12. Furthermore, the right total

LMS was 0.46 ± 1.28 and the left total LMS was 0.50 ± 1.41, both with a range from 0 and 12. The right sphenoid sinus had the highest percentage (98.4%) with a LMS of 0 that is complete lucency. The left maxillary sinus had the highest percentage (12.2%) with an LMS of 1 that is partial lucency and while the left ostiomeatal complex had the highest percentage (5.9%) with an LMS of 2 that is complete opacity or obstructed. Overall, the bilaterally total LMS were 0 (complete lucency of all sinuses) in 63.3% of individuals (310 of 490) across the all of the enrolled CT scans (Fig. 2).

In terms of season of the scan (Fig. 3), the bilateral total LMS was 1.36 ± 2.25 (n=112) in the spring (December, April, May), 0.64 ± 1.85 (n=133), in the summer (June, July,

Figure 1



1a 1b

1c 1d

Figure 1. a. Lund-Mackay scores (LMS) of the right maxillary sinus, left maxillary sinus, right ostiomeatal complex and left ostiomeatal complex of 0, 2, 0, and 2, respectively. **b.** LMS of the right frontal sinus, right anterior ethmoid sinuses, right ostiomeatal complex, and right maxillary sinus of 0, 1, 2, and 0, respectively. LMS of the left frontal sinus, left anterior ethmoid sinuses, left ostiomeatal complex and left maxillary sinus of 1, 1, 2, and 1, respectively. **c.** LMS of the right posterior ethmoid sinuses and left posterior ethmoid sinuses of 1 and 0 respectively. **d.** LMS of the right and left sphenoid sinus of 0 and 2 respectively.

Table 1.

	Right			Left		
	0	1	2	0	1	2
Frontal sinus	97.6%	1.4%	1.0%	98.0%	1.2%	0.8%
Maxillary sinus	85.9%	11.6%	2.4%	84.9%	12.2%	2.9%
Anterior ethmoid sinus	92.9%	5.7%	1.4%	93.1%	5.5%	1.4%
Posterior ethmoid sinus	94.9%	4.1%	1.0%	95.5%	3.5%	1.0%
Ostiomeatal complex	95.7%		4.3%	94.1%		5.9%
Sphenoid sinus	98.4%	1.0%	0.6%	96.9%	2.4%	0.6%

Figure 2

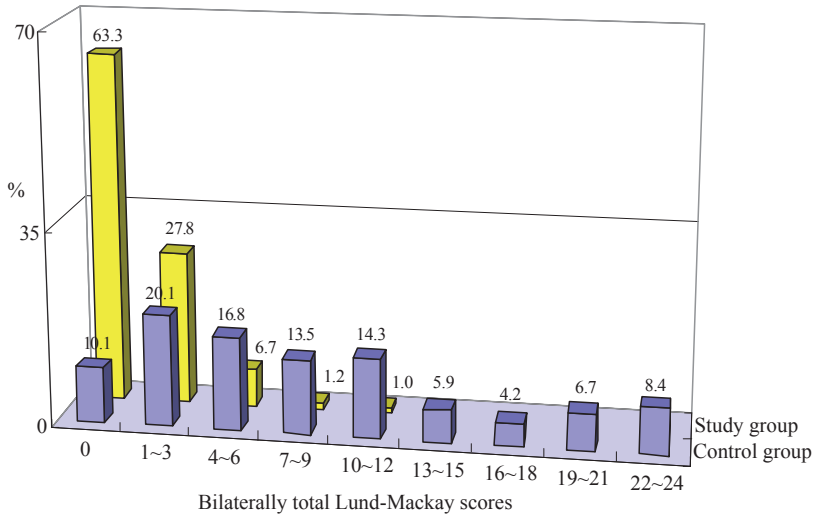


Figure 2. The bilaterally total Lund-Mackay scores distributions of the study group and control group.

Figure 3

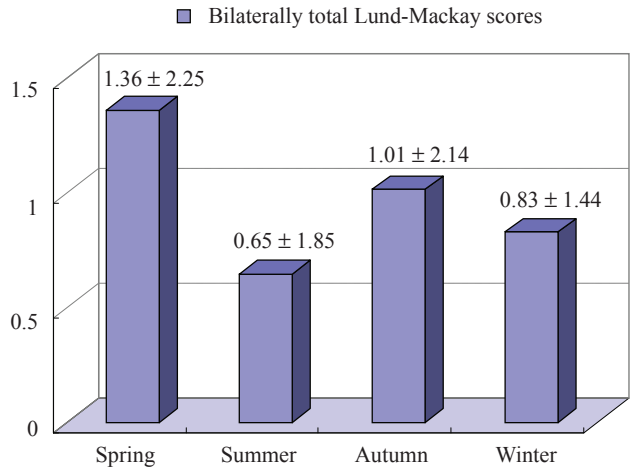


Figure 3. The bilaterally total Lund-Mackay scores in terms of season of the scan.

Figure 4

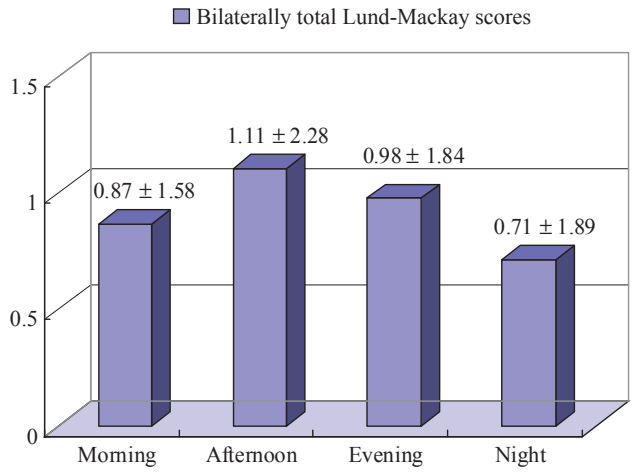


Figure 4. The bilaterally total Lund-Mackay scores in terms of the time of the scan during the working day.

August), 1.01 ± 2.14 (n=152), in the autumn (September, October, November) and 0.83 ± 1.44 (n=93), in the winter (December, January, February). In terms of the time of the scan during the working day (Fig. 4), the bilaterally total LMS was 0.87 ± 1.58 (n=272) during the morning; 1.11 ± 2.28 (n=170) during the afternoon; 0.98 ± 1.84 (n=41) during the evening; and 0.71 ± 1.89 (n=7) at night.

Control Group

The bilaterally total LMS was 8.72 ± 7.18, with a range from 0 and 24. Furthermore, the right total LMS was 4.35 ± 3.84 and the left total LMS was 4.37 ± 3.98, both with a range from 0 and 12.

Statistical Analysis

Between the study group and the control group, there was no significant difference in the age between the study group and the control group (p=0.35); however, there was significant difference in the either-side LMS for frontal sinus (p=1.0×10^{-9}), maxillary sinus (p=6.2×10^{-18}), anterior ethmoid sinus (p=1.6×10^{-24}), posterior ethmoid sinus (p=3.4×10^{-17}), ostiomeatal complex (p=2.5×10^{-11}) and sphenoid sinus (p=2.7×10^{-9}), and unilaterally total LMS (p=8.2×10^{-20})(Table 2); in addition, there was significant difference in the bilaterally total LMS (p=1.5×10^{-21}) (Fig. 2).

DISCUSSION

When a sinus CT is carried out, its purpose is always an assessment of rhinosinusitis. This contrasts with head and neck CT, where the imaging purposes were variable and not targeted at rhinosinusitis. Based on this fact, head and neck CT scans could provide a control LMS dataset. However, based on Huang et al's research [5], that patients (1) with head and neck cancer treated by radiotherapy, (2) with rhinosinusitis that has already been diagnosed, treated or operated on, and (3) who have suffered from head or facial trauma should be excluded because these conditions increase LMS value. Although one patient may have more than one CT scan within the dataset, we only enrolled the first CT scan film for this study. It has been found that, although there was a very strong correlation (p<0.001) between the CT scoring of otorhinolaryngologists and radiologists, there is a modest discrepancy when grading the anterior ethmoid sinus and the ostiomeatal complex [6]; fortunately, the executing author has ever been engaged in otorhinolaryngological practice and therefore any grading discrepancies should be minimal in our study.

Using a normal population that has not been clinically diagnosed with rhinosinusitis, the bilaterally total LMS was reported by Ashraf et al. to be 4.26 ± 0.42 [4], and the separate unilaterally total LMS was reported by Huang et al. to be 0.83 ± 0.11 [5]. Although a bilaterally total score ranging from 0 to 24 and a separate unilaterally total score ranging from 0 to 12 were both suggested by the originator Lund [1], we thought the bilaterally total LMS was more practical and simple to use than separate unilaterally total LMS values. Our result for the bilaterally total LMS (0.96 ± 1.91) is statistically different (two-tailed Student's t-test, t=16.40) from that of Ashraf et al. [4], while our separate unilateral total LMS values (0.46 ± 1.28 and 0.50 ± 1.41) are also statistically different (two-tailed Student's t-test, t=4.22 and 3.42) from that of Huang et al. [5]. The score 1 "partial lucency" has not been well defined in the past studies despite our description in the materials and methods. Mild mucosal thickening in sinuses is common, and might be scored as 0 in one study but 1 in another so the disparity may contribute to the significantly different results between our study and others. In addition, our case number (n=490) was much greater that that of Ashraf et al. (n=199) [4] or Huang et al. (n=214) [5]. Using 97.7% of the common population, incidental rhinosinusitis may be impressed when a patient's bilaterally total LMS is great than 5 (mean plus 2SD is 4.78) or when a patient's unilaterally total LMS is greater than 4 (mean plus 2SD for right is 3.02 and for left is 3.32).

Table 2.

	Right			Left		
	Study Group	Control Group	p	Study Group	Control Group	p
Frontal sinus	0.03 ± 0.23	0.51 ± 0.78	1.0 × 10^{-9}	0.03 ± 0.21	0.55 ± 0.82	3.7 × 10^{-10}
Maxillary sinus	0.17 ± 0.43	0.93 ± 0.81	6.2 × 10^{-18}	0.18 ± 0.45	0.97 ± 0.77	7.0 × 10^{-20}
Anterior ethmoid sinus	0.09 ± 0.33	1.02 ± 0.78	1.6 × 10^{-24}	0.83 ± 0.32	0.94 ± 0.80	3.7 × 10^{-21}
Posterior ethmoid sinus	0.06 ± 0.28	0.71 ± 0.71	3.4 × 10^{-17}	0.06 ± 0.27	0.69 ± 0.78	1.2 × 10^{-14}
Ostiomeatal complex	0.09 ± 0.41	0.75 ± 0.96	2.5 × 10^{-11}	0.12 ± 0.47	0.82 ± 0.98	7.3 × 10^{-12}
Sphenoid sinus	0.02 ± 0.18	0.43 ± 0.68	2.7 × 10^{-9}	0.04 ± 0.22	0.41 ± 0.70	7.3 × 10^{-8}
Unilaterally total LMS	0.46 ± 1.28	4.35 ± 3.84	8.2 × 10^{-20}	0.50 ± 1.41	4.37 ± 3.98	1.2 × 10^{-18}

The sinuses and the ostiomeatal complex are physiologically living organs and therefore their mucosal condition changes with time, both during the day night and with changes in season. According to Huang et al. [5], the mean unilaterally total LMS shows an inverse ratio with seasonal temperature. Our study showed that the average bilaterally total LMS was lowest in summer and greatest in spring; however, the values for winter were lower than that of spring and autumn (Fig. 3). In North Taiwan, in addition to atmospheric temperature, it seems likely that the presence of flower pollen, spores, defoliation and other environmental factors are likely to influence rhinosinusitis via possible allergic reactions. In addition, Huang et al. [5] made the mistake of comparing separate unilaterally total LMS with the bilaterally total LMS of Ashraf et al. [4], and this led to the wrong conclusion that atmospheric temperature significantly influenced the LMS values.

We also found that, across the different times of day when the scans were carried out, the bilaterally total LMS was the least during the night and greatest during the afternoon (Fig. 4). However, the case number (n=7) for night was low and is not large enough to support speculation that sympathetic tone or temperature differences between day and night might influence rhinosinusitis. Nonetheless, this is the first study to investigate LMS values in terms of time during the day and night and suggests a trend that might be worth further study.

Kennedy proposed that a universal staging system providing uniformity when comparing the starting point with the outcome would result in better diagnosis and management of chronic rhinosinusitis [7]. Therefore, radiological scoring has been used as an attempt to base treatment decisions on factual data, although, in these circumstances, an appropriate use of radiological scoring should correlate with other clinical indicators, such as the Sino Nasal Questionnaire (SNAQ) [6], and the 20- or 22-question Sinonasal Outcome Test (SNOT) [3]. Nonetheless, it is quite easy for a radiologist to use the bilaterally or unilaterally total LMS values to describe the severity of rhinosinusitis [2], and this provides a clinical doctor with useful information.

CONCLUSION

Using enrolled head and neck CT scans, the bilaterally total LMS for Taiwanese individuals was 0.96±1.91. Furthermore, for the same individuals, the right total LMS was 0.46±1.28 and the left total LMS was 0.50±1.41. When a patient's bilaterally total LMS is more than 5 or when there is a unilaterally total LMS of more than 4, he or she is beyond 97.7% of the common population.

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